



PHENIX XENON GAS RECOVERY SYSTEM OPERATION PROCEDURE

procedure name

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REVISION CONTROL SHEET

LETTER	DESCRIPTION	DATE	WRITTEN BY	APPROVED BY	TYPED BY
A	First Issue	5/8/2000	R. Pisani	E. O'Brien, R. Pisani, R., Giannotti, A. Etkin	n/a
Inactive	Retired	5/31/2007 Gas Recovery not in use. May be re-activated in the future if gas recovery is re-instated.		Inactive Status approved by D. Lynch, R. Pisani & P.Giannotti for the PHENIX Collaboration	LOR by D. Lynch

Operating the PHENIX Xenon Recovery System

1.0 Purpose and Scope

The scope of this procedure is those operations that are necessary for running the East Transition Radiation Detector (TRD) with a mixture of 45%He + 45%Xe + 10% CH₄ using the TEC /TRD gas system, see Fig. 1, together with the Xenon Recovery system.

Operations in this procedure include the following:

1. Purging the Xenon Recovery System (XRS) with inert gases.
2. Purging the XRS with the mixture of 45%He + 45%Xe + 10% CH₄
3. Normal Operation Mode
4. Xenon removal from the cryostats

In the operation described here, inert gases (Nitrogen and Helium) and the mixture are routed from the TRD. The gas flow in the TRD Vent Line is typically 0.5 - 5 LPM at a pressure of 2 mmWC. Critical pressures and flows of the gas system are monitored by a hardware alarm box as well as a dedicated computer program.

The primary purpose of this operation is to recover Xenon from the mixture for the duration of the PHENIX operations. PHENIX Drawing # 002-0206-911B (Sheet 2), see Fig. 2, contains the definition of recovery system controls and instrumentation.

2.0 Prerequisites

2.1 Required training to operate the Xenon Recovery System in the manner described in 1.0 above:

- 2.1.1 BNL General Employee Training (GET)(V-001)
- 2.1.2 BNL Compressed gas safety course (OSH026)
- 2.1.3 BNL Cryogen Safety course (OSH025)
- 2.1.4 TEC/TRD gas system and Xenon Recovery System training with a previously qualified gas system operator.

3.0 Precautions

- 3.1 Over pressurization of the TRD (above 7 mmWC) will result in severe structural damage. Primary care should be given to monitoring the internal pressure of the East TRD throughout the duration of this procedure, especially when adjusting flow rates and when the hardware and software alarms are bypassed.
- 3.2 PPE: according to the cryogenics safety regulations the operator should wear gloves, an apron and safety goggles/face shield.

4.0 Procedure

4.1 Initial Setup

NOTE: The following procedure assumes that the East TRD has been flushed with nitrogen and that auxiliary systems have been turned on. TRD Leak rate does not exceed 0.2LPM. Xenon Recovery System pipes were purged with inert gas and cleaned with Helium. Both Xenon Cryostats insulating volumes were pumped to 10^{-3} Torr. 6.9L Cylinders (C1, C2) and the 43.5L cylinder were pumped to 10^{-2} Torr via MV17.

- 4.1.1 Confirm that MV Bypass 2 (the large S.S. gate valve) is open and MV Bypass 1 (top of TRD gas rack in the GMH) is closed
- 4.1.2 Confirm that there is the flow through FI8 at TEC gas rack in the GMH.
- 4.1.3 Confirm that MV5, MV7 and MV6, MV8 are closed.
- 4.1.4 Confirm that MV14, MV15 and MV16 are closed.
- 4.1.5 Confirm MV9 is closed.

4.2 Purging the Xenon Recovery System with inert gases

- 4.2.1 Open MV1, MV2, MV3, MV4.
- 4.2.2 Open MV10, MV11, MV12, MV13.
- 4.2.3 Close MV Bypass 2
- 4.2.4 Purge the cryostats at least 1 hour with a flow 5LPM with 90%He + 10% CH₄ gas mixture from TRD exhaust line.

NOTE: Once an acceptable leak rate has been established, go to East TRD flow with 45%He + 45%Xe + 10% CH₄

4.3 Purging the TRD with a mixture of 45%He + 45%Xe + 10% CH₄

- 4.3.1 Turn ON AC power to Xenon Cryostats Rack.
- 4.3.2 Set TIC 1 and TIC 3 temperature to -112°C (161K).
- 4.3.3 Set TIC 2 and TIC 4 temperature to -163°C (110.2K).
- 4.3.4 Built up Dewars pressure to 8PSIG using cylinder's PCV.
- 4.3.5 Set FI1 and FI3 flow to 1LPM (1st stage N2 vents).
- 4.3.6 Set FI2 and FI4 flow to 2LPM (2nd stage N2 vents).
- 4.3.7 Set Scales readings to 0(Zero) for Cryostats 1 and 2.
- 4.3.8 Unblock Alarm TT1X and TT2X on TEC/TRD PC below 130K.
- 4.3.9 Purge 3 TRD's Volume (about 60 hrs. @ 5slpm)

NOTE: If the ambient temperature is below Xenon critical point (289K, 60F.), use a blanket with the electrical heater to increase C2 or C1 temperature up to 310K (98F) to remove as much Xenon gas as possible.

4.4 Xenon removal from the cryostats

- 4.4.1 Close MV3.
- 4.4.2 Check Scale of Cryostat 1.
- 4.4.3 Open MV3 when Cryostat 1 Scale reading reaches 30lb (about 30 days).
- 4.4.4 Close MV1.

Extracting Xenon from Cryostat 1

- 4.4.5 Block Alarm TT1X on TEC/TRD PC
- 4.4.6 Set TIC 1 and TIC2 to -108°C (165.2K)
- 4.4.7 Turn On S1 for the heater 1 and let the temperature stabilized
- 4.4.8 Close MV10 and MV11
- 4.4.9 Place C2 into the flask.
- 4.4.10 Fill flask with lq.N₂ and cool down C2.
- 4.4.11 Close MV2
- 4.4.12 Open MV5 and MV15
- 4.4.13 Open C2 valve
- 4.4.14 Slowly open MV14 and let Xenon gas go to C2.
- 4.4.15 Check Cryostat 1 Scale and keep C2 cool.
- 4.4.16 Close C2 Valve at 15lb Scale reading.
- 4.4.17 Close MV14.
- 4.4.18 Close MV15.
- 4.4.19 Remove C2 from the flask and let C2 warm up.
- 4.4.20 Turn MV9 to C2 direction.
- 4.4.21 Open 43.5L cylinder and check its pressure.
- 4.4.22 Close 43.5 Cylinder.
- 4.4.23 Open C2 Valve
- 4.4.24 Open 43.5L cylinder once the C2 pressure equals its pressure.
- 4.4.25 Close C2 valve and 43.5l cylinder valve once the pressure at PI3 has stabilized.
- 4.4.26 Place C1 into the flask and cool it down
- 4.4.27 Open C1 valve.
- 4.4.28 Slowly open MV15 and let Xenon gas go to C1.
- 4.4.29 Close MV5 valve at 0(Zero) Scale reading on Cryostat 1.
- 4.4.30 Close MV15.
- 4.4.31 Close C1 Valve
- 4.4.32 Turn MV9 to C1 direction.
- 4.4.33 Remove C1 from the flask and let C1 warm up.
- 4.4.34 Open 43.5L cylinder and check its pressure.
- 4.4.35 Close 43.5L cylinder
- 4.4.36 Open C1 Valve.
- 4.4.37 Open 43.5L cylinder if C1 pressure equals its pressure.
- 4.4.38 Close C1 valve and 43.5l cylinder valve once the pressure at PI3 has stabilized.
- 4.4.39 Open MV1 and MV2.
- 4.4.40 Turn OFF S1
- 4.4.41 Set TIC 1 and TIC 3 temperature to -112°C (161K).
- 4.4.42 Set TIC 2 and TIC 4 temperature to -163°C (110.2K).
- 4.4.43 Close MV1 when the TIC1 and TIC2 temperature will be stabilized.

- 4.4.44 Open MV10 and MV11.
- 4.4.45 Unblock Alarm TT1X on TEC/TRD PC
- 4.4.46 Check Cryostat 2 Scale readings.
- 4.4.47 Open MV1 if Cryostat 2 Scale reading is 30lb.
- 4.4.48 Close MV 3.

Extracting Xenon from Cryostat 2

- 4.4.49 Block Alarm TT2X on TEC/TRD PC
- 4.4.50 Set TIC 3 and TIC4 to -108°C (165.2K)
- 4.4.51 Turn on S2 for the heater 2 and let the temperature stabilized
- 4.4.52 Close MV12 and MV13
- 4.4.53 Place C1 into the flask.
- 4.4.54 Fill flask with lq.N₂ and cool down C1.
- 4.4.55 Close MV4
- 4.4.56 Open MV6 and MV16
- 4.4.57 Open C1 valve
- 4.4.58 Slowly open MV14 and let Xenon gas go to C1.
- 4.4.59 Check Cryostat 1 Scale and keep C1 cool.
- 4.4.60 Close C1 Valve at 15lb Cryostat 2 Scale reading.
- 4.4.61 Close MV14.
- 4.4.62 Close MV16.
- 4.4.63 Remove C1 from the flask and let C1 warm up.
- 4.4.64 Turn MV9 to C1 direction.
- 4.4.65 Open 43.5L cylinder and check its pressure on PI3.
- 4.4.66 Close 43.5 Cylinder.
- 4.4.67 Open C1 Valve
- 4.4.68 Open 43.5L cylinder if the C1 pressure equals its pressure.

NOTE: **If the ambient temperature is below Xenon critical point (289K), use a blanket with the electrical heater to increase C2 or C1 temperature up to 310K (98F) to remove as much Xenon gas as possible.**

- 4.4.69 Close C1 valve and 43.5l cylinder valve once the pressure at PI3 has stabilized.
- 4.4.70 Place C2 to the flask and cool down it
- 4.4.71 Open C2 valve.
- 4.4.72 Slowly open MV16 and let Xenon gas go to C2.
- 4.4.73 Close MV6 valve at 0(Zero) Cryostat 2 Scale reading.
- 4.4.74 Close MV16.
- 4.4.75 Close C2 Valve
- 4.4.76 Turn MV9 to C2 direction.
- 4.4.77 Remove C2 from the flask and let C2 warm up.
- 4.4.78 Open 43.5L cylinder and check its pressure.
- 4.4.79 Close 43.5L cylinder
- 4.4.80 Open C2 Valve.
- 4.4.81 Open 43.5L cylinder if C2 pressure equals its pressure.
- 4.4.82 Close C2 valve and 43.5l cylinder valve once the pressure at PI3 has stabilized.

- 4.4.83 Open MV3 and MV4.
- 4.4.84 Turn OFF S2
- 4.4.85 Set TIC 3 temperature to -112°C (161K).
- 4.4.86 Set TIC 4 temperature to -163°C (110.2K).
- 4.4.87 Close MV1 when TIC3 and TIC4 temperature have stabilized.
- 4.4.88 Open MV12 and MV13.
- 4.4.89 Unblock Alarm TT2X on TEC/TRD PC.

Schematics

Fig. 1 shows a schematic of the TEC/TRD gas system with the Xenon recovery system placed on the current vent line (red box, upper right). The physical location of the recovery system is the PHENIX gas pad. All controls and alarm functions integrate into the existing TEC gas system.

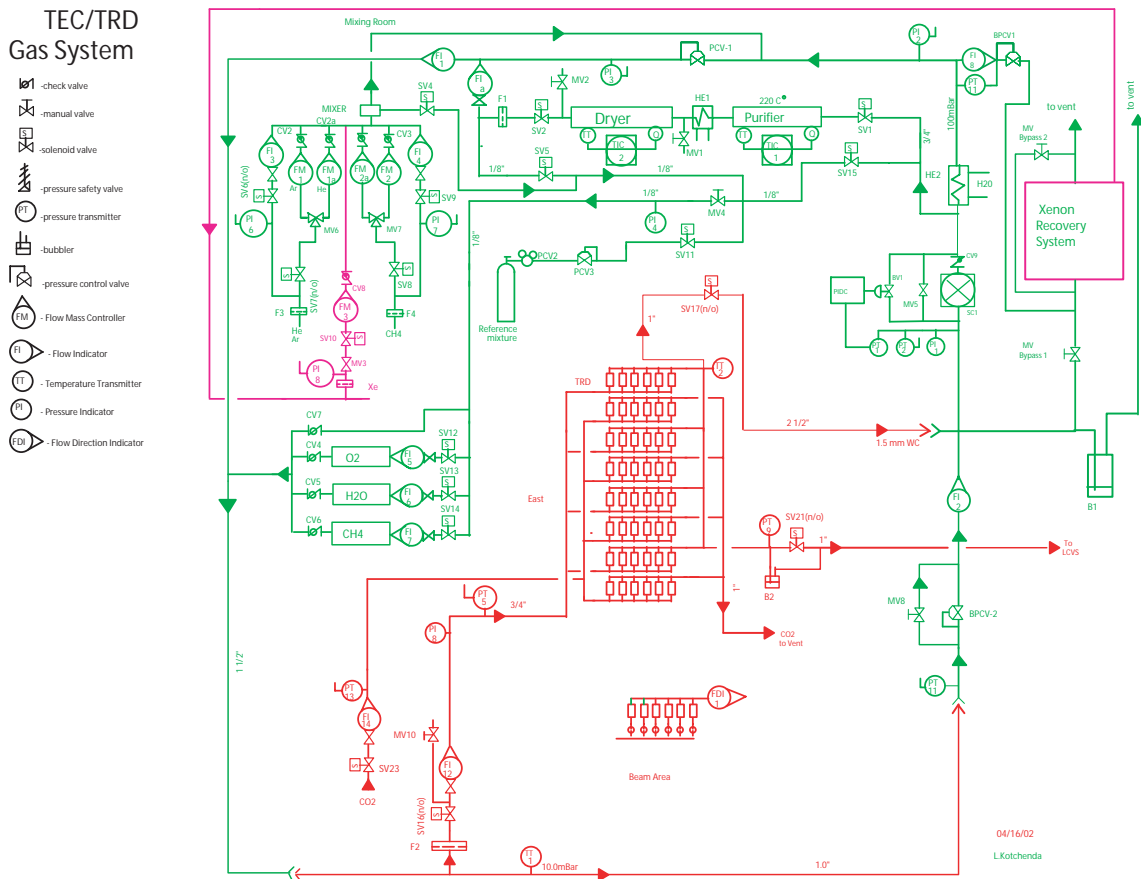


Fig. 1. PHENIX TEC/TRD Gas System

The recovery system extracts Xenon from the 45%He+45%Xe+10%CH₄ mixture venting from the chambers by use of a cold trap. The collected solid Xe is recovered, first to a transfer bottle in liquid form and then placed as a gas into commercial storage cylinders for re-introduction into the system.

The Xenon Recovery System

The Xenon recovery system itself is shown in Fig.2. It includes two low temperature cryostats, each capable of accumulating up to 6 liters of liquid Xenon. The cryostats have two stages of Xenon separation at different cryogenic temperatures, a first stage at 161K and a second stage at 110K where solid Xenon will be collected. For normal operation only one cryostat will be in the running mode, with the second one in standby. For TRD purging or power failures, both cryostats will be employed.

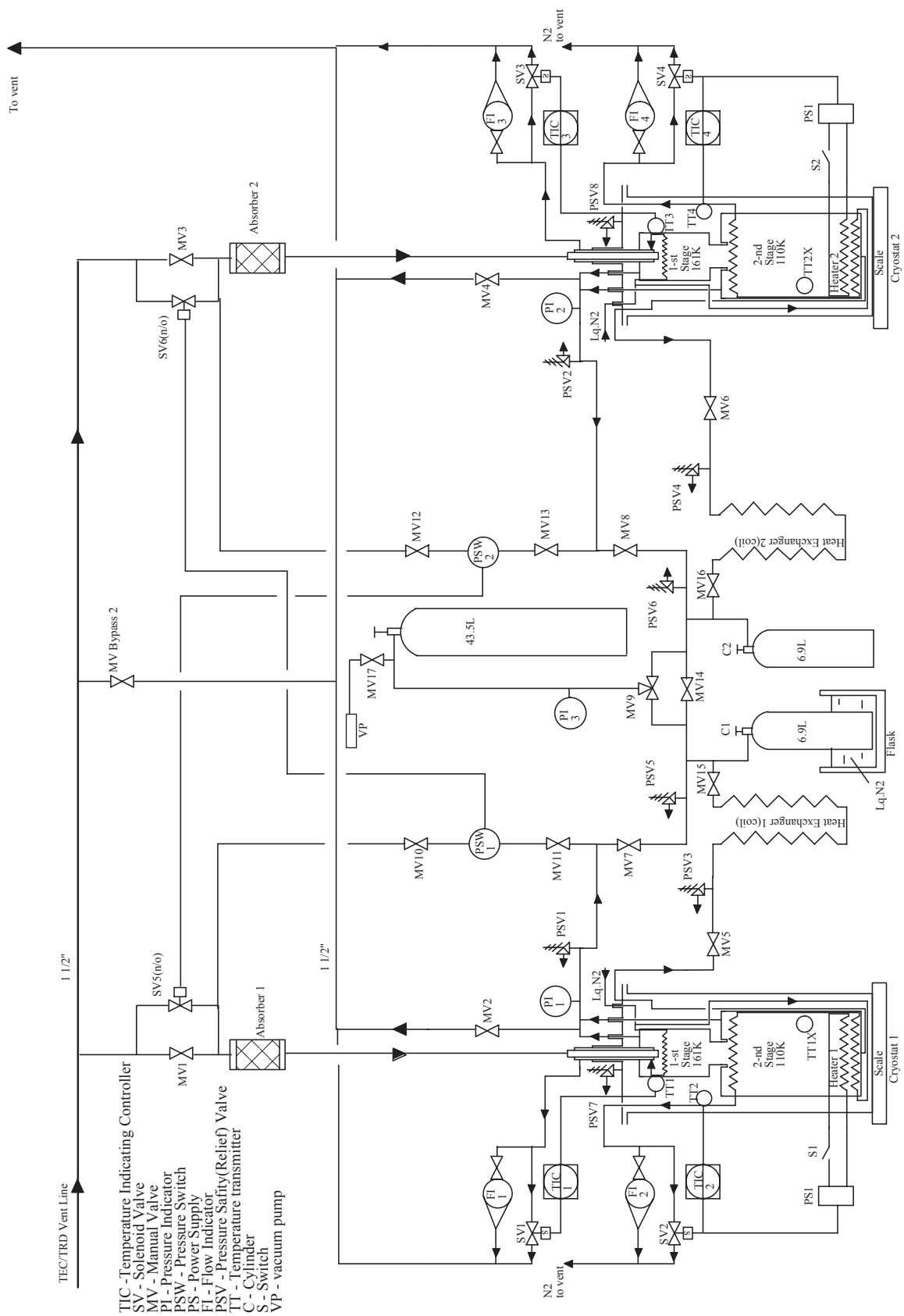


Fig.2. Xenon recovery system (TEC/TRD Gas System schematic 002-0206-911, Sheet 2)